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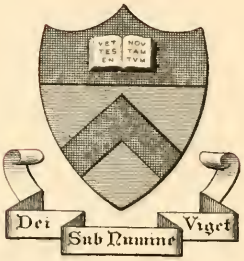

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SYLLABUS

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BOTANY and ZOOLOGY

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BIOLOGY.

Biology is science of living things.

Botany is science of plants.

Plant is made up of stem, leaves and roots, (also a fourth part—hairs).

Leaves consist of green leaves and flower.

FLOWER.—Its Structure.

Seed produced by flower which is a specialized shoot with leaves grouped together at top. It (normally) consists of four rows of parts.

I. Two rows of perianth-leaves—(a) The calyx outside, whose leaves are small and green and are called sepals. (b) Corolla within calyx, with leaves colored and called petals.

II. Two rows of reproductive organs. (a) Stamens with the corolla surporting filament with anther which contains the pollen. (b) Pistil, consisting of three parts, viz.: (1) Ovary or seed vessel. (2) Style or stalk surmounting the ovary. (3) Stigma, supported by the style, and is a terminal enlargement of the pistil.

These parts are isomerous, *i. e.*, having same number of divisions in each whorl (row). Members of adjoining rows alternate. A stamen corresponding to interval between two petals is opposite a sepal. Flowers have frequently a double row of stamens.

FERNS.

Ferns are a species of cryptogams (flowerless plants.) The full-grown fern produces, without fertilization, spore-cases (reproductive cells) on back of its leaves.

From these spore-cases grow up a small kidney-shaped leaf about $\frac{1}{4}$ inch in diameter, called the prothallus. This bears many active sperm-cells and one germ-cell. This germ-cell, being fertilized by the sperm-cells, grows in its place upon the prothallus, but finally takes root in the earth

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and becomes a large fern. The prothallus then withers and dies. Thus the fern has alternation of generation, the first generation being non-sexual and the second (the prothallus) hermaphrodite.

ZOOLOGY.

The animal kingdom is made up of two divisions—VERTEBRATA and INVERTEBRATA.

VERTEBRATA are those having either backbone or notochord. INVERTEBRATA include all animals not possessing backbone nor notochord.

VERTEBRATA.

REPTILIA.—Have no hair nor feathers. Sometimes have spines. Body scaled. Toes, when present, usually five in number, having claws. Ribs well developed. Young generally hatched from large egg. A few forms are ovoviviporous, *i. e.*, retaining egg in body till hatched. Great diversity in habits and consequently of vast variety as to form and structure. All are air-breathing. Eyes with two lids, nose with nostrils. Blood circulation incompletely double. No metamorphosis. Heart composed of three chambers. Two auricles and one ventricle. One occipital condile joins head to body, and quadrate bone supporting under-jaw. Vertebræ hollow in front and convex behind. Teeth present or absent. Limbs well developed. Shoulder girdle and corocoid bone well shown. Sometimes the limbs are wanting.

MAMMILIA.—Those which suckle young. Variety of habits and sizes. Warm-blooded.

Characteristics: Skull solid and strong. Under-jaw joined directly to skull with no quadrate bone. In consequence very strong under-jaw. This is made up of two bones. This group has two occipital condiles. 2600 species. Seven vertebræ in neck in all but two species—the sloth having six or nine and the sea-cow six. Shoulder degenerate, coro-

coid bone being degenerated to a small process as a piece of scapula. Pelvis greatly consolidated, and hence strong hind limbs. Limbs erect, facilitating locomotion. Caps, called epiphyses, on end of bones to facilitate growth, which disappear in adults. All mammals are oviparous, except spiny ant-eater and the duckbill, which bring forth young in eggs. Mammals are the only animals having hair.

Viscera: Heart of four chambers (two auricles and two ventricles). Single aortic arch going to left. Two separate streams of blood. Blood contains red and white corpuscles. Mammals only have diaphragm separating heart and lungs from lower viscera.

Brain: Optic lobes (or midbrain) disappearing, they are four in number and very small. A pineal gland present inside brain, a very small degenerate rudiment of a third eye. A connecting bridge (corpus collosum) between two divisions of brain. Sub-classes—Montremes, Marsupials and Placentals.

I. Montremes. — Rare and unimportant, found in Australia only; have no teeth, except when very young; bring forth young by eggs.

II. Marsupials or pouched animals. Found in Australia and North and South America. Bring forth young very small. Have two marsupial bones supporting the pouch. No placenta and have special arrangement in pouch for suckling young. Angle on underjaw bent inward.

II. Placentals.—Those animals having an arrangement (Placenta) for oxygenated air for young before birth. Young well developed at birth. Classified according to extremities of limbs. (a) Those having fins, (b) claws, (c) hoofs, (d) nails.

(A) Those Having Fins—(Whales and Mermaids.)

Hind limbs wanting, front limbs modified to serve as paddles, consisting of shoulder blade, humerus, ulna, radius, wrist bones and five digits. Nostrils in top of head. These are the so-called blow-holes. Skin folded to prevent water from entering air passages. All carniverous. Possess no hair. Tail horizontally flattened, by verticle movements of which locomotion is effected.

(B) Those Having Claws.

I. Low Group.—Smooth brain. (a) Edentata—True Anteater, Sloth. These possess no teeth. (b) Rodentia—Rats, rabbits, etc. Incisors well developed (c) Insectivera. (those feeding on insects)—Hedgehog, mole, etc. Teeth specialized. Incisors, canines, pre-molars, molars.

II. High Group.—Convoluted brain. Dog, weasel, cat, bear, seal. Most intelligent animal except man. These are the true carnivora. Mandible condile on back of under jaw, preventing lateral motion and giving great cutting power to teeth. Teeth specialized. Three incisors, one canine, one pre-molar and one molar on each side of jaw. Large zygomatic arch. Vertebræ bend easily. Only one bone in wrist. Toes four or five. Structure gives great strength and elasticity.

(C) Those Having Hoofs (Ungulata).

All herbiverous and generally large—with exception of Hyrax and Small Deer.

I. Odd Toed.—Tapir (3), Rhinocerous (3), Horse (1), Hyrax.

Tapir has four front toes and three hind. Distribution—South America and Indian Archipelago.

Rhinocerous.—Hard, rough skin, laid in folds and very elastic. No hair. Very large in size.

Hyrax.—Closely allied to Rhinocerous.

Horse.—Single hoofed, toes only reaching ground. Jaws elongated for grazing. Adapted to rapid motion by having no gaul-bladder, permitting uninterrupted digestion. Easily acclimated, changing coat readily.

II. Even-Toed.

Four-toed.—Peccary, Hog, Hippopotamus.

Two toed.—Camel, Deer, Giraffe, Prog-Horn.

The Ungulata, strictly so-called, have complete interlocking of wrist and ankle, which are elevated. This gives an extra joint. Toes are in gradual decrease from five to one throughout the different species. Even-toed have no third trocanter, but odd-toed have.

Elephants.

Wrist close to ground. Very ancient. Best developed teeth in animal kingdom. Brain well developed. Most of skull made of spungy bone enclosing brain cavity. Largest of Mammals, some weighing 10,000. Possess a long, fleshy, flexible proboscis, containing more than 40,000 muscles. This grows from front edge of nasal bone, ending in finger-like, very sensitive point. Upper incisors largely developed, forming tusks, which have perpetual pulp. No teeth in under jaw. No canines. Molars large and transversely ridged. Usually five-toed. Possesses zygomatic arch. Cheek bone far back. Jaws curved and shortened. Distribution (including Mammouths)—Russia, Switzerland, Africa, England, Western America, Asia.

(D) Those Having Nails—(Primates.)

Some have nails only on thumb. Brain large and usually convoluted. Limbs free. Have Clavicle, well developed. Five digits. Ankle and heel not elevated. Thumb always opposable. Eyes look forward, and are separated from temporal fossa. Attitude tends to be erect. This group includes a great variety of forms, extending from Squirrels and Bats, as low forms, to the Monkey, Ape, and Man, high forms. Possess complete set of teeth. There are two subclasses: Prosimiae and Anthropoidea.

I. Prosimiae—(Lemurs)

Face and body covered with fur. Walk on all-fours. Long tails (Lori excepted). Skull flattened and small, narrow in front. Brain cavity proportionately small.

(A small Lemur, the Madagascar Cat, shows deviation in the arrangement of teeth, resembling Rodents rather than Primates. Thumb not opposable. Hind digits, except great toe, have claw-like nails. Considered by Evolutionists as coming from Insectivora. Habits nocturnal.)

II. Anthropoidea.

Characterised by large, convoluted cerebral hemispheres. Ears rounded, with distinct lobule. Mammae pectoral. (a) Monkeys and Apes. (b) Man.

(A) Monkeys and Apes.—Body prone. Four-handed. Placenta like human being. Gorilla and Orang walk partly erect. Great toe opposable to fingers. Body very hairy. Head naturally hangs forward. Only one curvature in backbone. Low chin and forehead. Canine teeth large. New World species distinct from those of Old World species. Old World species have flat nose, thirty-two teeth, no prehensile tail. New World species, nose not so flat, but broader. A broad septum dividing nostrils. Thirty-six teeth—there being extra pre-molars. Tail often prehensile. Thumb sometimes wanting, and when present does not have freedom of movement.

(B) Man.

Characteristics.—Omniverous. Double curvature in backbone. Enlarged in lumbar region, enabling erect attitude. Pelvis broad, and tail reduced to a few condensed vertebrae, called coccyx. Varieties: Long heads, short heads, middle heads. Preponderance of middle heads. Races: White, Yellow, Black. Distributed over whole earth.

Differences Between Gorilla and Man.

Man has reason, moral powers, speech, religious nature. Superiority in size and development of Man's brain, weighing 3 lbs., double that of Gorilla; overhanging eye-orbits. Gorilla has hollow forehead. Man stands erect, head upright, and great development and usefulness of Man's hand. Man only animal having even teeth. Arms of Monkey tribe longer, and more of the nature of legs. Man only truly walks.

INVERTEBRATA.

Those animals which possess neither back-bone nor notocord.

Mollusca (Clam, Snail, etc.)

Characteristics: Limbs wanting. No internal skeleton. Soft body, surrounded by a mantle, which secretes a limy covering (shell). Sexes usually combined, but are not self-fertilising. Bi-symmetrical body. Alimentary tract separated from body cavity. Nutritive fluid is carried over body

and through gills, where it is purified by a system of blood vessels which lead to and form a muscular heart of two auricles and one ventricle. Nervous system well developed. Some breathe by gills and some by lungs, inhabiting both land and water.

Divided into three classes:

I. Univalved. II. Bivalved. III. Cephalopod.

I. Univalved (Snails).

Viscera protrudes from back. Alimentary canal coiled and long, and contains a series of teeth, called odontophore. Arms near mouth. Intestine penetrates the heart, which lies dorsally. Head placed anteriorly, bearing tentacles. An extension of belly is developed into the so-called foot, upon which he walks.

II. Bivalved (Clams, Oysters, etc.)

Two adductile muscles, very powerful, attached to either shell. Valves united by hinge.

III. Cephalopods (Cuttlefish, Nautilus, etc.)

Possess odontophore and strong jaws. Large number of radiating arms surrounding mouth and bearing suckers on end. Eyes well developed. Brain protected by cartilaginous box. Special means of locomotion, the siphon, by means of which it can eject water taken in between body and shell, thus sending itself in opposite direction.

Crustacea (Lobster, Crab, Shrimp).

These are gill-bearing Arthropods, and form the most extensive branch of Animal Kingdom. Body divided into 20 or 21 segments. Jointed appendages. Body protected by a hard external shell, which is divided into two regions. Nervous system consists of brain connected with ventral ganglia by means of æsophagal ring. Alimentary tract separated from by cavity. Circulatory system imperfect. Blood colorless. Heart dorsal. No capillary vessels; a number of large vessels supply all the body. No lymphatic system. Alimentary canal divided into three parts, most of it belonging to posterior portion. Hard jaws in stomach. Integument hard, by deposition of living matter. Possess

two pairs of antennæ. Abdomen and thorax may bear appendages. They pass through a series of metamorphoses. The young animal small, free swimming, and possessing three pairs of appendages, which develope into two pairs of antennæ and jaws. Outgrowths: flaps, limbs, hair, wings. Ingrowths: tendons joining limbs to body; alimentary canal lined by ingrowth as far as stomach; also ingrowth forming a belly-bone to support nerve-chord. The nervous system has seven sense organs. Possess compound eye. Barnacles are hermaphrodite, with an extra complimentary male. Some forms have followed a retrograde development, losing head, eyes and limbs. Root crabs lose every regular organ that would represent a crustacean.

ECHIODERMATA—(Spiny Skinned—Star Fishes, etc.)

These present a radical structure. Digestive tract not connected directed with body cavity. Skin hardened, calcerous plates. Generally free swimmers. All are marine. Subdivisions: Crinoids, Asteroids, Echinoids, Holothuroids.

I. CRINOIDS.

Extremely rare and found only in deep water. A long stem attached to mud by root-like branches supports a five-rayed animal of the appearance of a lily. Mouth placed in center of disk from which the rays diverge. A limy deposit prevents quick contraction of any part of the animal and renders movement slow. Has an alimentary tract which adsorbs the food coming from aesophagus. Possesses a number of small tentacles (ambulacral appendages) on upper surface of each arm.

Larva has ciliated bands over body, enabling him to swim freely. In later stage he becomes fastened to some foreign substance and grows longer, the skeleton becoming better developed and body accomodating itself to the new form of skeleton. In still higher, tentacles grow around the mouth and the body becomes still more elongated. In final stage he moves freely through the water, with set of long arms. (Complete metamorphosis.)

II. ASTEROIDS—(Star Fishes.)

Possess from five to twenty rays—five rays regularly,

but these are sometimes subdivided. Body much flattened. Has ambulacral appendages in rows on lower side of each ray, which may be thrust forward and become attached to foreign bodies, being provided with terminal suckers. These suckers are used in locomotion and in acquiring food. Ambulacral system used in inflating himself with water. He is not supported by a stalk. There is a little opening in top of animal into which the water goes down through a cileated canal into the ring surrounding aesophogus, thence into small radial vessels, suporting tube-feet. These tube-feet have power to hold to any substance, however smooth, by means of regulating its radial vessels. The water which supplies the ambulacral suckers enters through red, seive-like arrangement called " coral-plates."

He has power to supply lost parts. The starfish is very damaging to oyster beds.

Echinoids (Sea Urchins).

Calcerous plates firmly united, precluding motion between them. A shell is thus formed, perforated with numerous pores, through which ambulacral suckers are thrust. Provided with protecting spines, in appearance and shape very much like a chestnut bur. Mouth below and anus above. Has five sharp ivory teeth, each supported by complex bones, about forty in number. This structure is known as " Aristotle's Lantern." These teeth are capable of cutting very hard substances. Stomach elongated, extending clear to anus.

IV. Holothuroids (Sea Cucumbers).

Highest form of Echinoderms. Five-rayed structure in the ambulacral suckers, when present. Skin tough and strong, containing numerous calcerous plates. Body elongated, and presents a marked bi-lateral symmetry. When alarmed he can eject his viscera. Possesses power of replacing lost parts. Breathes by taking water in through anus, which passes to a respiratory tree which supplies function of a lung.

CŒLENTERATA (Corals, etc.)

No blood vessels, no separate stomach, no proper intestine. One cavity performs all functions. Exterior body covered by numberless cells, which can throw out long threads with poisonous ends, used for protection and in securing food. All aquatic. Great variety in size. Sub-classes: Hydrazoa, Actinozoa.

I. HYDRAZOA.

(a) HYDRA.

One-quarter inch long; deep green or brown in color. Elongated body with opening at apex. Radiate structure. Tentacles surrounding mouth. In summer it multiplies by budding. These buds stick on foreign substances and reproduce by eggs the following spring, when they move about as plants and then grow into the animal. They are hermaphrodite.

(b) JELLY FISH.

Egg becomes attached and develops into a form resembling the Hydra. The part of body above tentacles continues to grow and becomes of great size. It soon divides into a series of "saucers," the upper ones breaking away from those below become a separate Jelly-fish.

II. ACTINOZOA.

Exclusively salt water animals. Large in size. Mouth opens into bag-like stomach through œsophagus, thence into the body cavity. These parts are held in position by a series of fleshy partitions. Reproductive organs are internal. Sea Anemone is a small animal, usually attached to foreign substances, having power of throwing out poisonous barbs. Usually has six tentacles.

CORALS.

(a) Eight tentacles. Red coral. Has bony axis, flesh and separate zoads. Eight cavities. Found in Mediteranean, and are very valuable.

(b) Six tentacles. Six cavities. These form coral reefs. The so-called coral reefs are only capped with coral. The limy structure of the animal is the reef formation.